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Review of Electric Vehicle Developments 1980

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ABSTRACT

The report reviews the state of the development of electric vehicles and their progress towards economic viability at the end of 1980. The more significant news and events are discussed and views from abroad are presented. The final conclusion is that while the electric car may be inevitable in the long run, progress is slow and the development of new, cheap, very efficient midget gasoline cars may tend to postpone the time when electric cars will become viable.

1/ INTRODUCTION

This report is the second of a series of annual reports that have been prepared to summarize important new developments related to the viability of electric vehicles and their future role as personal transportation.

1.1/ Current Electric Car Performance

The implications of the electric car performance developments are much easier to understand if electric car performance is described in terms of the equivalent gasoline driven car. For the purpose of comparison it is convenient to use the Volkswagen Rabbit as this car has been converted to an electric car. This car has also been selected by the U.S. Department of Energy for the purpose of demonstrating the viability of electric cars. Ontario Hydro has also selected this car as one of the vehicles for their test programme. The pertinent data are shown in Table 1.

Table 1/ Comparison of Regular Car with Electric Car

	Regular Car	Electric Car
Approximate Cost	$7,500	$20,000
Curb Weight	1930 lb.	3100 lb.
	870 kg	1400 kg
Propulsion battery	-	1170 lb.
	-	527 kg
Range per refuel/charge	250 miles	44 miles
	400 km	71 km
Time to refuel/charge	4 min	8 h
Seats	4	2
Cost of fuel/electricity	1.7¢/km	1.1¢/km
Cost of battery	-	6.5¢/km
Effective cost of fuel/electricity	1.7¢/km	7.6¢/km
Tax on fuel/electricity	0.46¢/km	-
Real cost of fuel/electricity	1.24¢/km	7.6¢/km

It should be noticed that the Rabbit body has all the cost benefits derived from mass production and the electrical propulsion system is one of the least expensive available. Significant reductions in cost, therefore, may not be achievable in the future.

The implications of the Table 1 data for the car owner may be described as follows. The initial price of the electric car is over two and one-half times the cost of the regular car. This includes a massive battery "gas tank" which adds 527 kg (1170 lb.) to the car weight and displaces two seats. Unfortunately, this "gas tank" holds only the equivalent of 6.8 L (1.5 gallons) of "gasoline"; or enough for 70 km (44 miles) of urban travel, and takes eight hours to "fill"; or charge. On days when the temperature is below freezing, the "gas tank" may only hold the equivalent of 3.4 L (0.75 gallons) for a range of 35 km (22 miles). Furthermore, the capacity of this "gas tank" is highly sensitive to the manner in which the car is driven. A "heavy foot" tends to reduce the "gas tank" capacity.

After a few months the "gas tank" starts to develop an ever-increasing leak - the battery deteriorates - which tends to gradually reduce its effective capacity and the travel distance between charges. The rate of reduction of capacity is also sensitive to the "heavy foot" so that between 15 000 and 22 000 km (9 400 and 14 000 miles), when the range becomes intolerably low, it becomes necessary to replace the "gas tank" at a cost of about $1,200 or 6.5 ¢/km (10.5 ¢/mile). This cost adds considerably to the actual electrical energy cost of 1.1 ¢/km (1.75 ¢/mile) to produce a total effective fueling cost of 7.6 ¢/km (12.25 ¢/mile). This compares unfavourably with the gasoline version at a fuel cost of only 1.7 ¢/km (2.7 ¢/mile).

When the above effective energy cost is added to the high initial cost of the electric cars, then the life cycle cost of the car becomes prohibitively high, far exceeding the cost of gasoline saved.

The main obstacles to electric car viability can be summarized as;

(a) High initial cost of the car and charging facilities.
(b) High battery replacement cost.
(c) Inconvenience of low distance range.
(d) Effect of temperature on a range and vehicle performance.
(e) Inconvenience of an eight-hour recharge.

It is now possible to see how the more important events of the last year address and influence these obstacles.

2/ THE BATTERY

It is clear that significant improvements in the "gas tank" or battery performance are required before the general purpose electric battery automobile even approaches viability. In the last year, two significant "breakthroughs" were announced in connection with battery developments.

The first of these "breakthroughs" was announced by General Motors in September 1979. GM has developed a nickel/zinc battery which contains about 100% more energy per kilogram than the existing lead/acid batteries. This means that the capacity of the 550 kg or 1200 lb. "gas tank" is increased to 140 km or 88 miles. The basic problem of the nickel/zinc battery, however, is its short life and high initial cost. The initial cost is expected by other researchers to be nearly twice that of the lead/acid and its life cycle cost may be up to three times. This illustrates the main problem of batteries -- the desirable features tend to be mutually exclusive, that is, the increase in one parameter usually means trading off some other desirable feature. It should be noted that in October 1980, GM announced a delay in the introduction of their electric car by at least one year.

The other significant "breakthrough" occurred in June 1980 when Gulf and Western (G&W) described their zinc/chloride battery as "perhaps one of the most meaningful developments in energy research since the turn of the century".

This battery is a spin-off from the development of large capacity energy storage devices for use on electric utility systems. The optimum capacity of the utility storage cell unit turned out to be close to that required for an electric car. The battery is more like a fuel cell and is really a small complex automatic chemical plant. The energy is contained in an aqueous zinc/chloride crystalline slush. The slush must be produced by refrigeration while charging, and maintained between the freezing temperature and plus 9°C while in the car and during discharge.

The June announcement said that the battery had driven a converted car 140 miles at 60 m.p.h. and had survived 700 charge/discharge cycles. G&W fully expected to get to 200 miles per charge and that the battery would easily outlast the car. However, in October 1980, the U.S. Department of Energy announced that they had found "major shortcomings and some fundamental technical problems" in the G&W battery program. It also appeared that the G&W program was in serious trouble at the time the announcement was made in June. This "breakthrough" is a rather extreme case which illustrates a common characteristic of battery development. Projected improvements are invariably optimistic and usually lie just over the horizon.

In summary, the GW "breakthrough" appears to have lowered only one of the five obstacles, that of range, while the other four may have been increased. The capacity of the new "gas tank" has been doubled, while the tendency to leak is worse. Meanwhile, the initial and replacement costs of the "gas tank" appear to have increased substantially. A further side effect of this change is that the capacity of the charger required to provide an eight-hour recharge for twice the range will be doubled and require a special 30 A outlet on 220 V, such as those used by kitchen stoves and clothes driers. The G&W announcement, on the other hand, is simply misleading.

During this year, other battery research workers have improved the life of the lead/acid battery about 100% and increased its capacity by about 14%. These results are obtained from simulated road tests in the laboratory. Although no cost changes have been developed, these are encouraging results which will move the electric battery vehicle nearer to viability.

3/ OTHER ITEMS OF INTEREST

3.1/ Canadian Programs

St. Lawrence Seaway Program

This is an electric van testing program funded by the Department of Industry, Trade & Commerce and administered through Transport Canada. DSMA-ATCON of Toronto are managing a test and development program to test seven Marathon electric vans which are being used by the St. Lawrence Seaway Authority as utility vehicles. The total cost is about $1.7 million. DSMA-ATCON have developed a sophisticated mini-computer system which monitors and records the electric vehicle parameters on a continuous basis. The data are then extracted, analyzed and printed out by a regular computer.

This program is designed to provide user operating data and product improvement data which may lead to a more viable vehicle in the future.

Ontario Hydro Program

Ontario Hydro has initiated a plan to test up to 12 electric and hybrid vehicles within its normal fleet. The objective is to acquire firsthand experience and operating data on electric vehicles from the users and utility point of view. These data will enable Ontario Hydro to assess the future of electric vehicles, their impact on the utility system and on petroleum fuel savings.

3.2 Foreign Activities

U.S.A.

The large Electrical and Hybrid Program is moving along with some promising advances in battery performance in the laboratory and some improvements in the reduction of the energy required by the car and its propulsion system. In the area of the vehicle demonstrations, problems have been encountered in the late delivery of the test vehicles.

The U.S. Postal Service (U.S.P.S.) requested bids on a new fleet of 750 electric vehicles. They already have considerable experience with electric vehicles and wrote a specification around this experience. Unfortunately, the response of the seven bidders showed a mean price 3.8 times the price of the equivalent internal combustion engine vehicle. This price is well beyond what can be tolerated by a cost-conscious transportation manager and the U.S. Postal Service has since ordered two electric prototypes for testing from CommuterCars. The vehicle is a new improved version of the much maligned City Car. Subject to satisfactory testing, U.S.P.S. will order a fleet of 375.

A sophisticated marketing study presented at a major U.S. conference indicated that when potential buyers became better informed about currently available electric cars, they were much less likely to buy one. The large U.S. program is using demonstrations to inform the public about electric vehicles. This may prove counter-productive if the marketing study is correct.

EUROPE

The larger electric vehicle developers are tending to concentrate their efforts on commercial vehicles which have the most potential for being competitive and providing real cost benefit to the users.

The lead/acid battery is regarded by one developer as the only feasible battery for many years to come. On the other hand, two developers are pursuing the exotic high temperature 350°C sodium/sulphur battery.

An interesting development is taking place in England where two English universities are investigating an innovative reluctance motor and controller with a view to significantly lowering their production cost. This motor will lend itself to mass production with a low labour content and will marginally reduce total electric car costs.

In the U.K., the House of Lords Select Committee on Science and Technology published its report on electric vehicles. The report concludes, "It is possible that electric transport will never get over the many technological obstacles in its way...". Nevertheless, the Committee considers, on balance, that "the odds are in favour of electric vehicles and that, soon after the end of the century, they will make a valuable contribution to road transport".

The Committee said that U.K. funding to the level of the U.S.A. or Japan was out of the question. However, the present system of sharing costs with large resourceful developers should continue at current levels, with the emphasis moving towards the hybrid gasoline/electric vehicles.

The report also suggests that the benefits of electric cars are obtained by society while the cost burden falls on the individual car owner. This being the case, it would seem appropriate that the government share this cost burden where the benefit/cost ratio is favourable.

JAPAN

There is a tendency to assume that the well-known Japanese ingenuity is leading to much faster progress in Japan than elsewhere. It is of interest, therefore, to set down some revealing quotations from a recent candid article about electric vehicles in Japan.

"Those electric vehicles thus developed and put into practical use are enjoying the highest level in the world in both performance and techniques....However, these vehicles have some problems in both performance and economic use compared with those using internal-combustion engines. Of those electric vehicles put to practical use in our country, about 400 are for on-road use, and about 12 000 for off-road use." The U.K. has 4500 on-road vehicles.

The situation in Japan therefore, appears close to what it is in the rest of the world, that is, very slow progress since 1966 when modern development was first initiated.

In Japan, however, another highly significant development is taking place which may further retard the electric car progress. This development is the very high growth in sales of the midget cars and trucks which are called K-cars. These vehicles, by law, must be no more than 3.2 m (126 inches) long and 1.4 m (55.1 inches) wide with a maximum engine capacity of only 504 cc (33 cubic inches). These vehicles sell for about $2100 and are half as expensive to run as other compact cars. They also can do 50 m.p.g. and easily maintain 55-60 m.p.h. on the highway.

These cars are enjoying a 20% increase in sales over last year in the midst of generally declining Japanese auto sales. Some people are suggesting that these cars are the way of the future. If this is the case, this could be a severe setback to electric vehicles in Japan as they will become even less competitive in the future. The possibility of these midget cars making inroads to the North American market must be considered, with similar consequences for electric vehicles.

4/ SUMMARY

The current performance of the electric car compares very unfavourably with gasoline cars available today. If the cost of battery replacement is included as part of the fuel or energy cost, then the effective energy cost rises from 1.1 ¢/km to 7.6 ¢/km. This is well beyond the gasoline cost of 1.7 ¢/km. The energy cost and very high initial cost, which is over two and one-half times that of the gasoline car, imposes an intolerable cost burden on the electric car owner. The benefits of the petroleum fuel savings, on the other hand, accrue to society in general.

Progress towards correcting the economic disparity by technical means is very slow and punctuated by claims of breakthroughs which have doubtful validity. This seems to be the situation in all countries involved in electric car development. As a result, attention is being concentrated on economically viable, special purpose vehicles closely related to the milk float duty. Greater emphasis is also being placed on combining gasoline and electric power plants to produce hybrid vehicles.

An important report in the U.K. suggests that the electric car will be inevitable by the turn of the century and that government aid should be used to reduce the financial burden on the individual electric car owner and to share the development costs of the car. Such aid will, however, be very costly and may have little impact on petroleum consumption within the next 20 years.

In the meantime, midget cars are being produced in Japan which use 500 cc engines, are very cheap, very fuel efficient and becoming very popular. Thus, the gasoline competition to the electric car is a moving target which is capable of vast improvements in economy.

The future prospects of the electric car have never looked good and the events of the past year have not improved them significantly.